

[0160] Operation of the second tactile device 201 will be described with reference to FIGS. 19A to 19D, which show in combination a schematic vertical cross-sectional view and a plan view of the tactile unit 201 for easy reference.

[0161] The second tactile device 201 is arranged such that when the driver depresses the accelerator pedal 22 to accelerate the vehicle the vehicle 12, the second tactile device 201 will generate a wave motion traveling in a backward direction of the vehicle, which is transmitted to the bottom of the driver's foot F to thereby enable the driver to acknowledge the vehicle being in an accelerating state or condition. The wave motion has constant amplitude and a variable frequency Fv, which vary in direct proportion to the vehicle speed.

[0162] More specifically, with the shift lever placed in a forward position (first gear position or drive range position), the accelerator pedal 22 is depressed with the driver's foot F whereupon based on information pertaining to the vehicle speed and vehicle travel direction, the pedal tactile device 202 activates the actuators 122 in the front row X1 to thereby produce a series of transversely aligned projections 217 on a front surface of the flexible skin layer 216, as shown in FIG. 19A. Immediately after formation of the projections 217, the front row actuators 122 (X1) are deactivated and, at the same time, the second row actuators 122 (X2) are activated to thereby produce a row of projections 218 on the front surface of the skin layer 216, as shown in FIG. 19B. Soon after formation of the projections 218, the second row actuators 122 (X2) are deactivated and, at the same time, the third row actuators 122 (X3) are activated to thereby form a row of projections 219 on the front surface of the skin layer 216, as shown in FIG. 19C. Immediately after formation of the projections 219, the third row actuators 122 (X3) are deactivated and, in synchronism therewith, the actuators 122 of the floor tactile device 204 are activated to thereby form a row of projections 221 on a surface of a floor mat or surface sheet member (not designated), as shown in FIG. 19D. Immediately after formation of the projections 221, the floor actuators 122 are deactivated and, at the same time, the front row actuators 122 (X1) of the pedal tactile device 202 are activated.

[0163] The foregoing sequence of operation is performed repeatedly, so that the flexible skin layer 216 on the accelerator foot plate 215 generates a wave motion traveling backward (toe-to-heel direction) at a frequency, which varies in direct proportion to the vehicle speed. The wave motion can be perceived by the driver as a sensation of something rubbing the foot bottom in the toe-to-heel direction. In this instance, since the frequency of the wave motion gradually increases with the vehicle speed, the driver is able to feel the acceleration of the vehicle 12.

[0164] Thereafter, when the driver starts releasing the depression on the acceleration pedal 22 to thereby slowdown the vehicle 12, the second tactile device 201 will generate a wave motion traveling forward (heel-to-toe direction), which is transmitted to the bottom of the driver's foot F to thereby enable the driver to acknowledge the vehicle being in deceleration state or condition. In this instance, since the frequency of the wave motion decreases with the vehicle speed, the driver can feel the deceleration of the vehicle.

[0165] More specifically, as shown in FIG. 20A, when the driver starts releasing the depression on the acceleration pedal, the second tactile device 201, on the basis of vehicle speed information, first activates the actuators 122 of the floor tactile device 204 to thereby produce a row of projections 221

on the front surface of the floor mat or surface sheet member. Immediately after formation of the projections 221, the actuators 122 of the floor tactile device 204 are deactivated and, at the same time, the third row actuators 122 (X3) of the pedal tactile device 202 are activated to thereby produce a row of projections 219 on the front surface of the skin layer 216 of the accelerator foot plate 215 (FIG. 18A), as shown in FIG. 20B. Immediately after formation of the projections 219, the third row actuators 122 (X3) are deactivated and, at the same time, the second row actuators 122 (X2) are activated to thereby produce a row of projections 218 on the front surface of the skin layer 216, as shown in FIG. 20C. Soon after formation of the projections 218, the second row actuators 122 (X2) are deactivated and, at the same time, the front row actuators 122 (X1) are activated to thereby form a row of projections 217 on the front surface of the skin layer 216, as shown in FIG. 20D. Immediately after formation of the projections 217, the front row actuators 122 (X1) are deactivated and, in synchronism therewith, the actuators 122 of the floor tactile device 204 are activated to thereby form a row of projections 221 on the surface of the floor mat or surface sheet member, as shown in FIG. 20A.

[0166] The foregoing sequence of operation is performed repeatedly, so that the flexible skin layer 216 on the accelerator foot plate 215 generates a wave motion traveling forward (heel-to-toe direction) at a frequency, which varies in direct proportion to the vehicle speed. The wave motion can be perceived by the driver as a sensation of something rubbing the foot bottom in the heel-to-toe direction. In this instance, since the frequency of the wave motion gradually decreases with the vehicle speed, the driver is able to feel the deceleration of the vehicle 12.

[0167] By thus forming the wave motions of different travel directions depending on the acceleration/deceleration of the vehicle, the vehicle accelerating/decelerating conditions can be clearly discriminated by the driver. It is possible according to the present invention to arrange the second tactile device 201 such that a wave motion traveling in the heel-to-toe direction is produced during reverse (backward) traveling of the vehicle. In such instance, mode selection is made between the deceleration mode and the reverse travel mode by using the tactile pattern input section 45 (FIG. 1).

[0168] As described above, the second tactile device 201 is well adaptable to a change in the vehicle traveling direction. It is possible according to the invention to operate the first-mentioned tactile device 42 (composed of the left and right tactile devices 51 and 53 assembled in the steering wheel 31) in the same manner as the second tactile device 201, in which instance the steering tactile device 42 still operates to change the travel direction of the wave motion at the occurrence of steering operations with predetermined steering angles. Selection of operation mode of the first tactile device 42 between the steering mode and the travel direction mode can be made by using the tactile pattern input section 45 (FIG. 1).

[0169] FIG. 21 shows still another form of application of the tactile device according to the present invention, which employs the driver's seat 15. As shown in this figure, a third tactile device 231 comprised of three rows of linear reciprocation actuators 122 is incorporated in a seat cushion 232 of the driver seat 15 with the actuator rows lying in the width direction of the vehicle. The front-row actuators 122 are disposed adjacent a front edge 234 of the seat cushion 232, central-row actuators 122 are disposed in a central portion